DOCUMENT RESUME

ED 025 010 EA 001 762

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Research Management.

Organisation for Economic Cooperation and Development, Paris (France). Directorate for Scientific Affairs.
Pub Date Jul 65
Note- 21p.
Available from- OECD Publications Center, Suite 1305, 1750 Pennsylvania Ave., N.W., Washington, D.C. 20006 (No. 18755, $0.80).
EDRS Price MF- $0.25 HC- $1.15
Descriptors- *Administrator Role, Bibliographies, *Management, *Research, *Research and Development Centers, *Research Directors, Researchers, Research Projects

Thirty-four key ideas on research and research management summarize the views of scientists in charge of research institutes who attended three regional seminars held in 1960 and 1961 in France, Austria, and Denmark. Meaningful research, whether pure, directed, or applied, requires professional management by directors who are technically skilled in their respective scientific disciplines and who are capable administrators of programs that require longrange planning, fiscal expertise, flexibility, and special ability in human relations. Research programs should be flexibly organized to allow free circulation of ideas and the most efficient use of research staff. A bibliography of 26 books, reports, and monographs published between 1955 and 1964 is appended. (JK)

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RESEARCH MANAGEMENT

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The Organisation for Economic Co-operation and Development was set up under a Convention signed in Paris on 14th December 1960 by the Member countries of the Organisation for European Economic Co-operation and by Canada and the United States. This Convention provides that the O.E.C.D. shall promote policies designed:

- *to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the world economy;*
- *to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development;*
- *to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.*

The legal personality possessed by the Organisation for European Economic Co-operation continues in the O.E.C.D. which came into being on 30th September 1961.

The members of O.E.C.D. are Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

The Directorate for Scientific Affairs, which is responsible for the publication of the present report, has been established within O.E.C.D. to take charge of the activities of the Organisation relating to scientific research and to the expansion and rational utilisation of the scientific and technical personnel available so as to meet the needs arising from economic growth.

INTRODUCTION

The Committee of Applied Research of the European Productivity Agency of OEEC, at the suggestion of several Member countries, organised a series of regional seminars where scientists in charge of research institutes or their immediate deputies have been able to exchange their views and experience in the research management field.

These seminars have been held at Ménars, in France, in April 1960; at Strobl, in Austria, in May 1961 and at Hornbaeck, in Denmark, in September 1961. The working languages were, respectively, French, German and English. In accordance with instructions from the Committee for Scientific Research of OECD, a small group, under the chairmanship of Professor H.W. Julius, and including Messrs. R. Ashton, F. Grill, B. Lavesen and Claude Oger met in Wassenar, near the Hague, in order to consider the results of the three regional seminars. Among others, the group formulated the recommendation that one or several pamphlets on Research Management should be published.

The Committee for Scientific Research then decided that a booklet dealing with the synthesis of ideas of the seminars, as well as with a summary of the research manager's responsibilities, means and methods, should be published.

The experience of many eminent managers and leaders of research has been drawn upon in preparing this booklet, which has been drafted by M. Alain Pons, consultant to OECD.

RESEARCH MANAGEMENT

1. There is no longer any need nowadays to emphasize the importance of scientific and technical research in national life and nobody today would dare echo the jest of the French revolutionary : "The Republic has no need of scientists ! " Research is no longer done merely to satisfy our curiosity and improve our knowledge of natural phenomena ; it now concerns all sectors of a country's activity, its defence and its civilian economy. Today, a nation's power and prosperity are largely determined by the scale of its research effort. This explains the proliferation of public and private research establishments of all sizes.

2. Research is generally divided into three types. First there is *pure research* which is a long-term undertaking unrelated to any immediate practical problems but designed to improve our knowledge of science and the laws of nature. It is chiefly carried out in university laboratories.

3. *Directed research* is long-term basic research which has been channelled into specific directions and is aimed at the solution of practical problems. It is carried on in universities, technical colleges, state-aided laboratories, independent contract research institutes and the laboratories of big industrial firms.

4. *Applied research* is the direct servant of technology. It is designed to improve existing products manufacturing processes or to develop new ones ; in extreme cases merges into industrial production. All industrial firms of any size have applied research laboratories.

5. Research establishments have ceased to be small "patriarchal" units gathered around a few outstanding scientific personalities who use them principally for their own research. Modern research laboratories and particularly those working on directed and applied research are part of the country's economic life and are therefore subject to the exigencies which govern the day-to-day life of modern industrial firms. Inasmuch as it is an essential factor in industrial development and prosperity research can no longer be carried on anarchically, at the whim of

individual inspiration. It must be conducted on lines likely to ensure maximum efficiency and output.

6. It is for this reason that a thorough examination of the factors which make for the effective management of research has became more and more urgent. It has been said that we live in the age of the managers; scientific and technical research could not expect to remain untouched by this development, and in fact a new discipline has been born - research management, or the administering and organising of research. It is not, or not yet, in the correct sense of the term, a science. We shall see that it contains as much art as science, depending on personal talent and intuition as much as on rules and principles. However, in recent years the directors of research laboratories, research scientists and the ultimate users of the results of research have had many opportunities in conferences, seminars and other meetings to talk about their experience, gained in a wide variety of different types of research. Their comments and observations have enabled the main problems to be clearly stated, have brought out a number of common factors and have shown the validity of certain basic rules; the knowledge thus gained will help avoid many pitfalls and mistakes in the future and contribute to more efficient and fruitful research. We shall try to bring out in the remainder of this brochure the principal conclusions and recommendations which have emerged from these exchanges of first-hand practical experience.

7. But there is one fundamental question which arises at the very outset : *How and under what conditions is it possible to organise or manage research ?*

A manufacturer who has decided to add a research unit to the other departments in his firm might begin by imagining that the management principles he has adopted for his production and sales departments are valid for research, as after all research is intended to produce usable or saleable ideas. But he would be making a great mistake by failing to see that scientific research is a distinct activity which has its own very special characteristics and requirements.

8. The fact is that there is no fundamental difference between modern scientists and those who built up science and technology in past ages. Methods and resources are not the same but the spirit of research has not changed any more than the qualities it calls for and the conditions which determine its success. The modern research worker is still a man who seeks to understand and who sets out to force nature to yield up her secrets. He must have a creative mind, and must be able to see relationships between phenomena which nobody had previously thought of connecting; he must also have a critical outlook, question things that are taken for granted and be for ever asking new questions in order

to produce new answers. His main qualities are as much intuition as patience and no less imagination than strict logic. A research worker can only thrive in an atmosphere of freedom which leaves him at liberty to choose his own methods and adopt his own rate of work. His efficiency cannot be measured by the number of hours he spends in front of his instruments for it contains an element of inspiration which cannot be pinned down by any regulation or governed by any plan.

9. But the industrial research worker, though employed in a laboratory is ultimately in the service of an industrial firm, i.e. an economic organism governed by the laws of productivity. He must not be content to seek, he must also find and, to some extent, he must even find what he is asked to find. He is therefore inevitably subject to the constraints of the specific objectives set for him, the resources and the time allotted to him; this is where organisation and management come into the picture.

10. There might seem to be a contradiction between these two requirements, *freedom of research* and *organisation,* but they can and must be reconciled. When either of these two elements gains the upper hand, research is paralysed. If research workers are left entirely to their own initiative there is a risk of anarchy, sterility and waste of both time and money in useless research and abortive projects. But if on the other hand a research assignment is forced into a rigid mould and over-supervised the creative spirit tends to disappear, the research worker becomes afraid to show initiative, he feels himself a mere cog in a bureaucratic machine and loses any taste for original work.

11. If research is properly organised and managed it will avoid these two dangers by *combining freedom and organisation* and thus foster an atmosphere which the creative spirit can develop freely. Organisation is not an end in itself, it is at the service of the research worker. Its task is to strike a balance between his interests as a scientist and the economic objectives pursued by the economic unit for which he is working.

The research manager

12. "Man, Money, Masonry, Materials" : these "four M's" sum up the conditions required for any successful research. The last three factors are essential but only man, the first element, can give them value. Financial allocations, buildings, equipment are worthless if they are not in the hands of a highly-skilled research staff. "Man", in this instance, is not only the research worker but also his chief, the *research manager.*

13. The responsibilities of the research director are heavy. They are of two kinds : he is responsible to the organisation or firm which pays

for the research, and he is responsible to the research staff. This two-fold responsibility is a personal one since he is at the head of a separate service or department. He attends the meetings of the Board and takes part in the elaboration of general company policy (at least it is to be hoped he does, for the days when research was merely a secondary, ancilliary service which did not merit a place on the Board are over). The programme of research is, of course, an aspect of general company policy and therefore the responsibility of the Board. But once the programme has been laid down it is the research director who is responsible for carrying it out. One cannot stress too strongly the need for continuous contact between research and the other departments of the firm. The research laboratory must not live in isolation, turned in upon itself; it must not forget that it is part of a larger whole, the firm which it has been set up to serve. It must not loose sight of the fact that it is not there no engage in research for its own sake, but in directed or applied research, i.e. research aimed at promoting the economic interests of the firm. On the other hand, the Board and the other departments must recognise that research work has its own imperatives, its own rythm, its difficulties, uncertainties and above all that it cannot produce results to order. Many of the conflicts which arise all too often between research, production and sales departments are based on misunderstandings which can only be avoided by continuous close co-operation. For this reason it is preferable that research facilities should not be isolated geographically from the other departments of the firm; distance makes contact more difficult and tends to encourage research workers to shut themselves up in a world of their own.

14. The double responsibility of the research director, and the importance of liaison with his colleagues elsewhere in the firm, call for qualities which it is often difficult to find in one and the same man. In the first place he must be a genuine scientist or technician; his authority over his staff will depend much less on his qualities as an administrator than on scientific or technical eminence. Only the latter can enable him to assess the ideas submitted to him, work out programmes and supervise their execution. This does not mean that he must know everything and be able to follow the operations of his staff in every detail. It may even be said that a good research manager should not seek to do too much himself. He must be able to delegate responsibility when necessary, spot good ideas and have confidence in the men from whom they come. However, it does take long experience and unusual acumen to know where to place one's confidence.

15. The research manager is not only a scientist but he is also an *administrator* and the head of a service. He must therefore be an efficient organiser, alive to economic problems and business management

methods. He must be able to draw up a budget, work out the cost of a programme and apportion the funds he receives.

16. Lastly, research management calls for very special ability in the matter of human relations. A good research manager can be recognised by the quality of his relations with his colleagues in other departments and above all, with his research staff. For a researcher is not a mere operative who is engaged to carry out the specific tasks assigned to him as accurately as possible and who is easily replaceable if he does not prove satisfactory. The fact that research is being done means that something has not yet been found and that nobody knows exactly where the trail is leading. The research manager decides the *functions* of his research staff, i.e., the direction in which they must go but each research worker is responsible for his own *operations,* is free to use his own ideas. That is why no research worker can be replaced easily. The manager must know the abilities, the style and the methods of those who work with him if he is to know what responsibilities he can assign to them and what results he can expect. Results cannot be measured by hours spent in the laboratory and visible activity. A particular research worker may well appear to be wasting his time whereas, in his own way and perhaps even unconsciously, he is on the track of a precious discovery; fussy supervision and sharp reproofs will only irritate and inhibit him. Research management demands a very subtle psychological sense. Personal troubles may sometimes interfere with a man's work and the manager must make allowances. Research is not blind routine work; the personal and human element plays a vitally important part in it. Creative inspiration cannot be conjured up to order; it can, however, be fostered, and this is the role of the research manager.

17. *Scientist, administrator, psychologist,* it is not easy to combine these three qualities in one man. Very great scientists may be poor research managers if they are unable to adapt themselves to the exigencies of economics and the demands of team work. That is why it is desirable that scientists who are going in for research management should be given special training to familiarise them with the administrative problems they will have to face and which are not strictly scientific, e.g., problems of staff, buying equipment, budgeting, accounting, etc. There are still only extremely limited possibilities in Europe of training research workers in research management; they have to learn very largely from their own experience and that of others. It is, however, becoming more and more widely recognised that there is a need for systematic, specialised training which will supply a positive groundwork of rules and principles soundly based on practical experience, and help future research managers to avoid the errors and pitfalls of the past.

18. This interplay between management and free initiative which is the basis of research can be seen in operation when *research programmes* are being worked out. It is essential to have a programme in order that the available intellectual and material resources shall be mobilised and oriented in a given direction in line with company policy. But it must not be too rigid, otherwise it will be an obstacle to creative freedom. It must also be open to correction and new suggestions and be able to adapt itself to unforeseen developments.

19. An industrial research programme must be based on a number of *major decisions*. These are taken at board of management level as they affect the whole policy of the firm and call for a co-operative effort from the production and sales departments no less than from the research unit. The presence of the head of the research laboratory at board meetings or management conferences where these major decisions are taken is obviously essential.

20. When agreement has been reached on these decisions the next step is to work out the research programme, whether they are long-term projects sometimes covering a period of about ten years or whether they are much shorter. This is the task of the research manager assisted by his research staff.

21. Fixing a programme first involves *choosing* between a number of ideas and projects. Where do these ideas and projects originate. To some extent they are called forth by the needs of the particular industry and the firm's general policy. But they can germinate mainly in the minds of the research workers themselves and here the research manager has an important responsibility. Admittedly, he is expected to have ideas but he should above all be able to accept ideas from others, recognise their value, assess them, select them and not dismiss out of hand the "wild schemes" which may turn out to be valuable. In this sense it may be said that he should *listen* rather than *talk*. The task of a research laboratory is to produce new ideas : a research manager cannot shoulder this responsibility alone ; he does not create new things but he manages them and enables them to materialise in tangible form. In this context the stimulating effect of outside contacts, with other research laboratories for example, should not be overlooked. The work of other scientists, their successes and their failures, always provide valuable lessons. Isolation, whether from non-scientific colleagues within the firm or from fellow scientists in other disciplines is one of the main enemies of creative and fruitful research.

22. One delicate problem involved in choosing from among ideas proposed for a research programme is the task of *costing* the projects. A

research laboratory has a certain budget and however generous this budget may be it is ultimately limited. The cost of a research project is much more difficult and much more uncertain to estimate than that of other investments. In the very nature of things, no one knows exactly where a piece of research is going to lead. At any moment a project may require recasting, unexpected difficulties may arise, new expenditure may be necessary. And the uncertainty is all the greater if a programme is a long-term one.

23. The research manager must therefore have fairly wide discretionary powers and sufficient independence in the use of his budget. With a little experience he should be able to estimate the cost of a programme of average size and this should give him a greater prospect of success in obtaining extra allocations when he launches out on a big project.

24. It is obvious that research programmes depend not only on their scientific and economic value and the budget available to the laboratory equipment and the skill and specialised knowledge of its staff: in a word, its material and intellectual *infrastructure*. It is sometimes impossible for a laboratory to tackle certain research which would require its complete reorganisation.

25. A programme is a framework designed to channel efforts, allot responsibilities and propose a time-table but it is not rigid and can always be *revised*. Hence the usefulness of periodic reports, regular or otherwise, which enable the research manager to estimate the progress made and decide whether the programme may have to be modified or even discontinued if there is no reasonable chance of success. The possibility of failure is in fact inherent in the very meaning of the word research and can never be absolutely dismissed.

The organisation and work and execution of research programmes

26. The *organisation* of research laboratories depends on their size. A laboratory which employs several hundred people cannot have the same structure as a medium-sized laboratory with a staff of no more than 50. However, most research establishments are subject to certain structural constants, due to two requirements. The first is to organise the laboratory in specialised departments and sections, each with its chain of command and the second is to avoid red tape as far as possible and ensure easy communication between the different departments.

27. The division of the research laboratory into substantially independent departments and teams is intended to meet the exigencies of specialisation and daily routine. The drawback of this "vertical" organisation however, is the creation of compartments between the

different branches of the laboratory with unfortunate results when a lengthy projects is being carried out and requires the co-operation of several departments. Research managers therefore generally try to replace this "vertical" organisation, or at least accompany it, by a more flexible, more permeable, "horizontal" structure,, reducing the chain of command to a minimum, allowing ideas to circulate more freely and enabling all the research staff to co-operate more closely in the joint task. This "horizontal" structure is particularly necessary for orientated research while the "vertical" and more formal structure is more suitable for applied research. One cannot lay down hard and fast rules; much depends on the size and nature of the firm. Generally speaking, isolation, introversion and even rivalry between the two different branches are dangers which a research manager must avoid.

28. The co-operation of the research staff must be as active in the *execution of the programme* as it has been in its preparation. So much intelligent initiative is required from research staff that they cannot be merely expected to carry out orders passively and unquestioningly. Research teams must be well briefed on the projects planned, their importance, their objectives, the expenditure involved and when possible the timetable it is hoped to work to. They must also always have an opportunity of "reacting" to the programmes and be given some responsibility in its revision.

29. There can be no actual research "planning" in the full sense of the word. Genuine planning presupposes that the operations, available resources and timetable have been worked out before hand and are known at each level of research. But in the very nature of things, research is a field in which the unknown and the unexpected can never be completely excluded and it will always be impossible to assemble all existing information at the outset and lay down an absolutely hard and fast timetable. All that can be done is to visualise the operational sequences and assign work with the maximum flexibility so that the targets can be gradually achieved.

30. If a research assignment is to be efficiently executed the working assumptions and schedule of experiments must first be adopted in the course of discussions attended by all those taking part in the project. The next point is to collect the necessary documentation (a specialised documentation branch is very useful and saves time) and install the requisite equipment. The research staff can then start work.

31. One of the most difficult problems of research management is the *efficient use of research staff*. There again, the problem is to reconcile organisation and free initiative, and to induce each man to do a specific job and even work in a particular direction and yet create conditions

which will enable him to work with zest and with a feeling of independence and this develop his full potentialities. If this is to be achieved he must of course be assigned tasks consistent with his abilities, his tastes and his way of working. A research manager must therefore have a thorough knowledge of his staff, their qualities and their short-comings and must also be well aware of the phycological problems inherent in any team work, particularly research. Some jobs are more glamorous than others, more important to the success of the programme and carry a higher prestive value. A whole compensatory mechanism is therefore required if feelings of frustration are to be avoided. From the point of view of promotion and salaries, the principle of the "double grading system", i.e. administrative and professional offers an advantage in that it does not handicap a highly qualified research worker who devotes himself to pure research as compared with the colleagues whose ability to command and organise bring him administrative responsibilities.

32. *Research control* is, at the outset, a personal control, carried out, for example, by statistical methods. It is then supplemented by the circulation of the results obtained at the different stages of execution enabling all those taking part in the research assignment, whatever their level, to verify the work done. Whether it is in the form of periodical reports or team conferences, the circulation of this information gives the management an idea of the progress made, the difficulties encountered and the action to be taken. It also ensures that the different sections are not isolated from each other and can co-operate fully.

33. When the research programme has produced successful results there remains the vital task of exploiting these results. From the scientific and theoretical point of view this exploitation consists of publishing articles or monographs, and taking out patents, in order to both safeguard the results and make them known to a wider audience, thus adding to the standing and scientific reputation of the laboratory and its staff. On the more practical level exploitation involves the rather tougher job of carrying the research results through *to the production and sale of new output;* this, after all, is the fundamental objective of all directed or applied research. No-one nowadays suppose that the passage from laboratory to production factory is a simple formality; it involves in most cases delicate and complex problems which can only be solved effectively through close co-operation between the research staff and that of development and production departments.

34. It is a great help if this co-operation is established while research work is still going on, and the location of laboratories and the production shops close together clearly facilitates contact between them. In cases involving new production processes which present special difficulties

it will often be necessary to develop a pilot plant in order to be able to study the problems associated with the change-over from single unit or small batch production in the laboratory to quantity production in the completely different conditions of the production shops. Here again close collaboration is essential and the research scientists must follow the progress of their work first through the pilot plant and then into production. A good practice now becoming more common is to appoint liaison engineers whose job it is to maintain permanent contact between the research and production staff responsible for specific projects. The liaison engineers are generally recruited from the research laboratory and thus have the scientific training necessary to carry back and explain clearly to their former colleagues in the laboratory the problems and difficulties encountered in production.

CONCLUDING NOTE

The main aim of this booklet is to enable the firm directors and managers to get a clear picture of what the item "Research Management" means, by providing them with a simple and succinctly-presented, but authoritative, scope of it.

It is also hoped that the inclusion of the important day-to-day problems will be most helpful to the scientists and mainly to those who are responsible for Research Management.

We also think that readers having a general or specialized knowledge of this matter will find the bibliographic list of works included very useful.

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